REMARKS

Present Status of Application

According to the Office Action dated September 06, 2005, claims 5 and 10 were rejected under 35 USC§102(e) as being anticipated by Danvir et al. (US Publication No. 2004/0169275). Claims 6 and 8-9 were rejected under 35 USC§103(a) as being unpatentable over Danvir et al. and in view of Nakazawa et al. (US Patent No. 6,448,665).

However, as discussed below, Danvir (US Publication No. 2004/0169275) does not qualify as a prior art under 35 USC 102(e) and, therefore, should be removed.

Discussion for 35 USC §102 and 103 rejections

Claims 5 and 10 were rejected under 35 USC§102(e) as being anticipated by Danvir et al. (US Publication No. 2004/0169275). Claims 6 and 8-9 were rejected under 35 USC§103(a) as being unpatentable over Danvir et al. and in view of Nakazawa et al. (US Patent No. 6,448,665).

The present application claimed the foreign priority of its corresponding Taiwanese Patent Application No. 92104000, which was filed on February 26, 2003. The U.S. filing date of the cited reference Danvir et al. (US Publication No. 2004/0169275) is February 27, 2003, which is later than the priority date (February 26, 2003) of the present application. Claims 5-6 and 8-10 of the present application are fully supported by the disclosure of Taiwanese Patent Application No. 92104000. Therefore, according to 35 USC 102(e) and 103(a), Danvir does not qualify as a prior art of the present invention as defined in claims 5-6 and 8-10.

A true English translation of Taiwanese Patent Application No. 92104000 and a statement by the translator under 37 CFR 1.55(a) are enclosed herewith for the purpose of ensuring the consistency of the contents between Taiwanese Patent Application No.

92104000 and the present invention.

Applicants believe that the above statement and the enclosed materials are sufficient evidences to disqualify US Publication No. 2004/0169275 (Danvir et al.) as a prior art under 35 U.S.C. 102(e) and 103(a) against the claims of the present application No. 10/789,171.

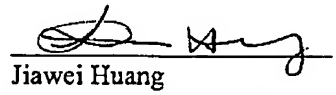
As a result, withdrawal of the rejections under 35 USC 102(e) and 103(a) is respectfully requested.

CONCLUSION

In view of the foregoing, it is believed that all pending claims are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,
J.C. PATENTS

Date: 11/7/2005



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In re application of:	TSUNG-MING PAI et al.	)
Application No.:	10/789,171	)
For:	FLIP-CHIP PACKAGE AND FABRICATING PROCESS THEREOF	)

VERIFIED STATEMENT OF TRANSLATION

COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Jiawei Huang, hereby confirm that the enclosed English translation is an accurate and true translation of the entire Taiwanese patent application No. 92104000 filed on February 26, 2003, entitled "FLIP-CHIP PACKAGE AND FABRICATING PROCESS THEREOF".

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 11/7/2005

Jiawei Huang

TRANSLATION

Specification for Patent Application

I. TITLE OF INVENTION□

FLIP-CHIP PACKAGE AND FABRICATING PROCESS THEREOF

II. INVENTOR(S):

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III. APPLICANT:

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IV. ABSTRACT OF THE INVENTION

A structure of a flip-chip package and a manufacturing process thereof are provided. The flip-chip package includes a chip, a substrate, a plurality of supporter and a plurality of conductive polymer bumps. The conductive polymer bumps are located between the chip and the substrate, for electrically connecting a die pad of the chip with a respective bump pad of the substrate. The center portion of the conductive polymer bump has a smaller diameter than that of the end portion of the conductive polymer bump. Moreover, the supporters are disposed between the chip and the substrate and distributed around a periphery of the active area of the chip, thus providing supports for the chip disposed on the substrate.

V. DESCRIPTION OF THE INVENTION

Field of the Invention

The present invention relates to a flip-chip package and a process for fabricating the same. More particularly, the present invention relates to a flip-chip package with electrically conductive polymer bumps disposed between a chip and a substrate, and to a process for fabricating the same.

Description of the Related Art

Flip-chip (FC) interconnect technology has been widely used in the package industry because it facilitates reduction of package area, shortening of signal transmission paths, and fabrication of package structures having high pin counts. In a FC packaging process, a chip is provided with bonding pads disposed on the active surface thereof and arranged in an area array, and bumps are disposed on the bonding pads. Then, the chip is flipped and situated over a carrier, and the bonding pads on the

chip and the bump pads on the carrier are electrically and mechanically connected via the bumps. Consequently, the chip is electrically connected to the carrier via the bumps, and further to outer electronic devices via the inner circuits of the carrier. Among all types of package structures utilizing the FC technology, the flip-chip ball grid array (FC/BGA) package and the flip-chip pin grid array (FC/PGA) package are frequently used.

FIG. 1 illustrates a cross-sectional view of a conventional flip-chip package. As shown in FIG. 1, the flip-chip package 100 includes a substrate 110, bumps 120 and a chip 130. The substrate 110 has a top surface 112, a bottom surface 114 opposite to the top surface 112, and bump pads 116 thereon. In addition, the chip 130 has an active surface 132, a back surface 134 opposite to the active surface 132, and bonding pads 136 thereon. The active surface 132 of the chip 130 is the surface formed with the active devices (not shown) of the chip 130. The bonding pads 136 are disposed on the active surface 132 opposite to the bump pads 116 serving as a medium for signal input/output, wherein each bump 120 electrically and mechanically connects a pair of bonding pad 136 and bump pad 116. Thereby, the signals from the chip 130 can be transmitted to the substrate 110 via the bumps 120, and further to an outer electronic apparatus like a printed circuit board (PCB) or a main board via contacts (not shown) disposed on the bottom surface 114 of the substrate 110.

Ordinary types of bump include solder bump, gold bump, electrically conductive polymer bump and polymer bump, wherein the solder bump is the most popular one, but is also relatively complicated and expensive in fabrication. Referring to FIG. 1, solder bumps 120 are conventionally fabricated with the following steps. An under-bump metallurgy (UBM) 138 composed of multi metal layers is formed on the

bonding pads 136 on the chip 130, wherein the metal layers usually include an adhesion layer constituted of Sb, W, Ni, Au, Cu or the alloys thereof, a barrier layer and a wetting layer that are formed with evaporation or sputtering. Thereafter, solder bumps 120 are formed on the under-bump metallurgy 138 on the bonding pads 136 by using a printing method or an electric-plating method, and are melted into spherical bumps in a reflow step and then cooled. The flux (not shown) on the surfaces of the solder bumps 120 are cleaned, and then the chip 130 is electrically and mechanically connected to the substrate 110 via the solder bumps 120. However, since the equipment for fabricating solder bumps is quite expensive and the fabricating process is relatively complicated, flip-chip packages cannot be fabricated with low cost in the prior art.

SUMMARY OF THE INVENTION

In view of the forgoing, this invention provides a flip-chip package and a process for fabricating the same to reduce the number of steps and the cost in fabrication of flip-chip packages.

The flip-chip package of this invention includes at least a chip, a substrate, supporters and electrically conductive polymer bumps. The chip has an active surface with bonding pads disposed thereon, and the substrate has a carrying surface with bump pads disposed thereon opposite to the bonding pads. The supporters are disposed between the chip and the carrying surface, and are distributed at the periphery of the active surface. Each electrically conductive polymer bump connects a bonding pad and a corresponding bump pad, and has a smaller diameter at the central portion thereof than at the end portions thereof.

Accordingly, this invention provides a flip-chip package process, suitable for connecting a chip to a substrate, wherein the chip has an active surface with bonding pads disposed thereon, and the substrate has a carrying surface with bump pads disposed thereon, wherein locations of the bump pads correspond to locations of the bonding pads, the process comprising at least the steps of: (a) disposing a plurality of supporters at a periphery of the active surface, and forming an uncured electrically conductive polymer bump on each bump pad; (b) situating the chip over the carrying surface to contact the carrying surface via the supporters; (c) pressing the chip toward the substrate to decrease the distance between the active surface and the carrying surface, so as to cause elastic strain in the supporters and increase a contact area between each pair of electrically conductive polymer bump and bonding pad; (d) stopping pressing the chip; and (e) curing the electrically conductive polymer bumps.

In a preferred embodiment of this invention, each supporter may be a gold bump that is formed by, for example, bonding a gold wire to the chip, and then pulling the gold wire apart to leave a portion thereof on the chip as a gold bump. In addition, the electrically conductive polymer bumps are preferably formed on the bump pads with a screen printing method.

Since this invention uses electrically conductive polymer bumps that are cheaper to fabricate than solder bumps to connect the chip and the substrate, the flip-chip package can be fabricated with a lower cost. Moreover, the fabrication of electrically conductive polymer bumps is simple and rapid, and the number of steps in the packaging process can be decreased.

It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGs. 2A-2C illustrate a process flow of fabricating a flip-chip package according to the preferred embodiment of this invention. Referring to FIG. 2A, a chip 210 having an active surface 212 with bonding pads 214 disposed thereon is provided, and supporters 230 are disposed at the periphery of the active surface 212 of the chip 210. The supporters 230 may be disposed outside the four corners of the active surface 212, and are formed as gold bumps, for example. Each gold bump can be formed by, for example, bonding a gold wire to the chip 210 with a wire bonding method, and then pulling the gold wire apart to leave a portion thereof on the chip 210 as a gold bump. During the wire-bonding step, a portion of each softened gold wire can be extruded into a spherical gold bump by using an existing fully-developed wire bonding apparatus, and then the other portion of the gold wire is pulled apart from the gold bump. Since the gold bumps are formed with an existing fully-developed wire bonding technique, the costs for fabricating a flip-chip package can be lowered.

Referring to FIG. 2A again, a substrate 220 having a carrying surface 222 with bump pads 224 disposed thereon is also provided, wherein each bump pad 224 is disposed at a position corresponding to that of a bonding pad 214. An uncured electrically conductive polymer bump 240 is formed on each bump pad 224. The electrically conductive polymer bumps 240 are preferably constituted of a polymeric material like polyimide or epoxy resin doped with many electrically conductive

particles made of silver (Ag), for example. Each electrically conductive polymer bump 240 can be formed on a corresponding bump pad 224 with a screen printing method.

Referring to FIG. 2B, the chip 210 is placed over the carrier surface 222 so that the bonding pads 214 on the chip 210 are aligned with the electrically conductive polymer bumps 240 on the substrate 200. At this moment, the chip 210 indirectly contacts the carrier surface 222 via the supporters 230. The supporters 230 support the chip 210 on the substrate 220, and the height "G" thereof is equal to the distance between the chip 210 and the substrate 220.

Referring to FIG. 2C, the chip 210 is pressed toward the substrate 220 to decrease the distance between the active surface 212 and the carrying surface 222 from "G" to "G1". Thereby, the supporters 230 are compressed to store elastic strain energy therein, and contact is made between each pair of electrically conductive polymer bump 240 and bonding pad 214. Consequently, each electrically conductive polymer bump 240 connects a bonding pad 214 on the chip 210 and a corresponding bump pad 224 on the substrate 220.

Referring to FIG. 2D, the pressure on the chip 210 toward the substrate 220 is removed, so that the strain energy in the supporters 230 is released. Thereby, the height of the supporters 230 relative to the substrate surface 222, i.e., the distance between the active surface 212 and the substrate surface 222, increases from "G1" to "G2". At this moment, the diameter "D1" of the central portion of an electrically conductive polymer bump 240 gets smaller than the diameters "D2" of the end portions because of the surface tension of the electrically conductive polymer bump 240. Thereafter, the electrically conductive polymer bumps 240 may be cured with a heating step to complete to flip-chip package 200.

As mentioned above, the flip-chip package disclosed in this invention includes a chip, a substrate, supporters like gold bumps, and some electrically conductive polymer bumps. The electrically conductive polymer bumps are disposed between the chip and the substrate electrically connecting the bonding pads on the former and the bump pads on the latter, wherein each electrically conductive polymer bump has a smaller diameter at the central portion thereof than at the end portions thereof. The supporters are also disposed between the chip and the substrate surrounding the active area of the chip, so that the chip can be supported on the substrate, with a distance (standoff) between the chip and the substrate equal to the height of the supporters. Since this invention utilizes the adhesion effect of the electrically conductive polymer bumps to connect the bonding pads and the bump pads with the distance between them being controlled by the supporters, the chip can be rapidly and easily mounted on the substrate. Therefore, the number of steps in the flip-chip packaging process can be decreased. Moreover, since the electrically conductive polymer bumps are fabricated with a screen printing method, they are cheaper than the conventional solder bumps in fabrication. Therefore, flip-chip packages can be fabricated with a lower cost by using the method of this invention.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention covers modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the above descriptions, serve to explain the principles of the invention.

FIG. 1 illustrates a cross-sectional view of a conventional flip-chip package.

FIGs. 2A-2D illustrate a process flow of fabricating a flip-chip package according to a preferred embodiment of this invention.

DESCRIPTION OF LABELS OF THE DRAWINGS

100: flip-chip package	110: substrate
112: top surface	114: bottom surface
116: bump pads	118: wiring layer
120: bumps	130: chip
132: active surface	134: back surface
136: bonding pads	138: UBM
140: solder balls	200: flip-chip package
210: chip	212: active surface
214: bonding pads	220: substrate
222: carrying surface	224: bump pads
230: supporters	240: conductive polymer bump
G, G1, G2: height	D1, D2: diameter

VI. WHAT IS CLAIMED IS:

1. A flip-chip package, comprising at least:

a chip having an active surface and bonding pads thereon, wherein the bonding pads are disposed on the active surface;

a substrate having a carrying surface and bump pads thereon, wherein the bump pads are disposed on the carrying surface opposite to the bonding pads;

a plurality of supporters disposed between the chip and the carrying surface and distributed at a periphery of the active surface; and

a plurality of electrically conductive polymer bumps, each connecting a bonding pad and a corresponding bump pad and having a smaller diameter at a central portion thereof than at end portions thereof.

2. The flip-chip package of claim 1, wherein the supporters comprise gold bumps.

3. The flip-chip package of claim 1, wherein each electrically conductive polymer bump comprises a polymeric material doped with a plurality of electrically conductive particles.

4. The flip-chip package of claim 3, wherein a material of the electrically conductive particles is silver.

5. A flip-chip packaging process, suitable for connecting a chip to a substrate, wherein the chip has an active surface with bonding pads disposed thereon, and the substrate has a carrying surface with bump pads disposed thereon, wherein locations of the bump pads correspond to locations of the bonding pads, the process comprising at least the steps of:

(a) disposing a plurality of supporters at a periphery of the active surface, and forming an uncured electrically conductive polymer bump on each bump pad;

(b) situating the chip over the carrying surface to contact the carrying surface via the supporters;

(c) pressing the chip toward the substrate to decrease the distance between the active surface and the carrying surface, so as to cause elastic strain in the supporters and increase a contact area between each pair of electrically conductive polymer bump and bonding pad;

(d) stopping pressing the chip; and

(e) curing the electrically conductive polymer bumps.

6. The flip-chip packaging process of claim 5, wherein disposing the supporters comprises disposing a plurality of gold bumps.

7. The flip-chip packaging process of claim 6, wherein in the step (a), disposing the gold bumps comprises:

forming the gold bumps from a plurality of gold wires with a wire bonding method; and

pulling the gold wires apart from the gold bumps.

8. The flip-chip packaging process of claim 5, wherein each electrically conductive polymer bump comprises a polymeric material doped with a plurality of electrically conductive particles.

9. The flip-chip packaging process of claim 8, wherein a material of the electrically conductive particles is silver.

10. The flip-chip packaging process of claim 5, wherein in the step (a) the electrically conductive polymer bumps are formed on the bump pads with a screen printing method.

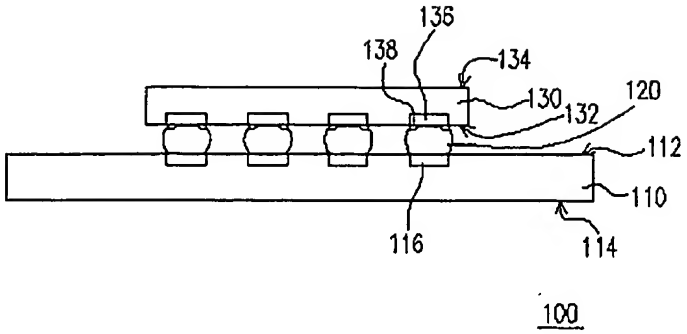

FIG. 1 (PRIOR ART)

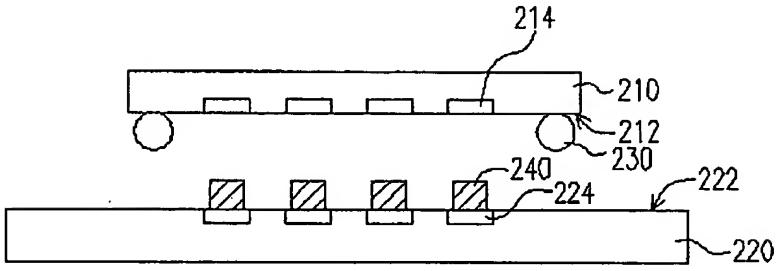

FIG. 2A

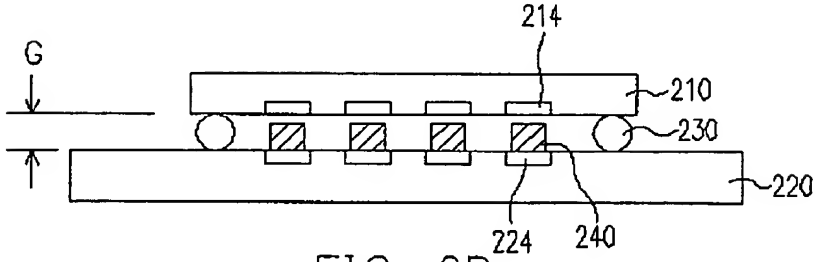

FIG. 2B

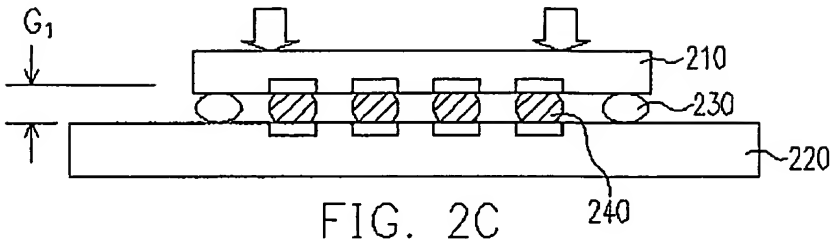

FIG. 2C

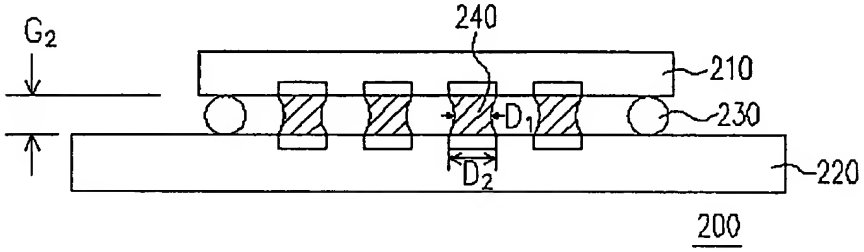

FIG. 2D